Space Weather Technical Forecast

Issued on Monday, 18 March 2024 at 13:04 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-flares (R1-R2 Radio blackouts). Slight chance G1 from CME arrival later on day 3 (20 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity in the past 24 hours with an M2.7 peaking at 18/0313UTC and originating from AR3612 in the northwest. This region has now rotated off the disc. Also, an M1.0 flare originating from AR3614 near the northeast limb was observed at 18/0414UTC. There are currently seven sunspot regions on the visible disc. AR3614 in the northwest is the largest and most complex with a clear delta configuration, and with further detail potentially becoming visible as it moves into a less oblique viewing angle. AR3613 is the next largest region, but of a relatively simple bipolar magnetic type. Small growth is occurring in AR3607 in the south-centre. The new region in the southeast is of note, as a source of the most frequent ongoing C-flaring, with notable looping and plage evident in SDO imagery. However this is currently at too oblique an angle for an accurate analysis. A further new region has also emerged in the northwest.

A broad filament eruption was observed from the southwest disc near AR3613, splitting to give two identifiable CMEs, one to the southeast and another to the southwest. The first has been analysed as faster and narrow, and likely to miss to the south, but with a chance of a glancing arrival on day 3 (20 Mar). The second was wider and slower, but more likely to arrive, currently expected later on day 3 (20 Mar). No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Solar winds were indicative of slow wind conditions, with the speed observed by ACE at background, easing from 350 km/s to below 300 km/s. Density has been below average throughout. Total Interplanetary Magnetic Field (IMF), Bt, was weak, at 5nT or below, with the north-south component also weak and mainly positive (northward), varying -1nT to +4nT. Phi angle was mainly positive (away from the Sun). Geomagnetic activity was Quiet (Kp=0-1 throughout).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux continued to ease after the S1 enhancement on 15-16 Mar, falling from 2.6 pfu to just below 1.0 pfu at 18/0000 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background levels. The observed 24-hour fluence was steady below the Active threshold, with the value at 18/0000UTC 5.97e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity expected with a chance of isolated M-class flares. These most likely from the new region in the southeast, or AR3614. There is a very slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: Glancing CME arrivals are possible days 1-2 (18-19 Mar) but these are low confidence, and most likely to miss. A more likely arrival is then expected day 3 (20 Mar), most likely from the slower of the two CMEs from the filament eruption on 17 Mar,

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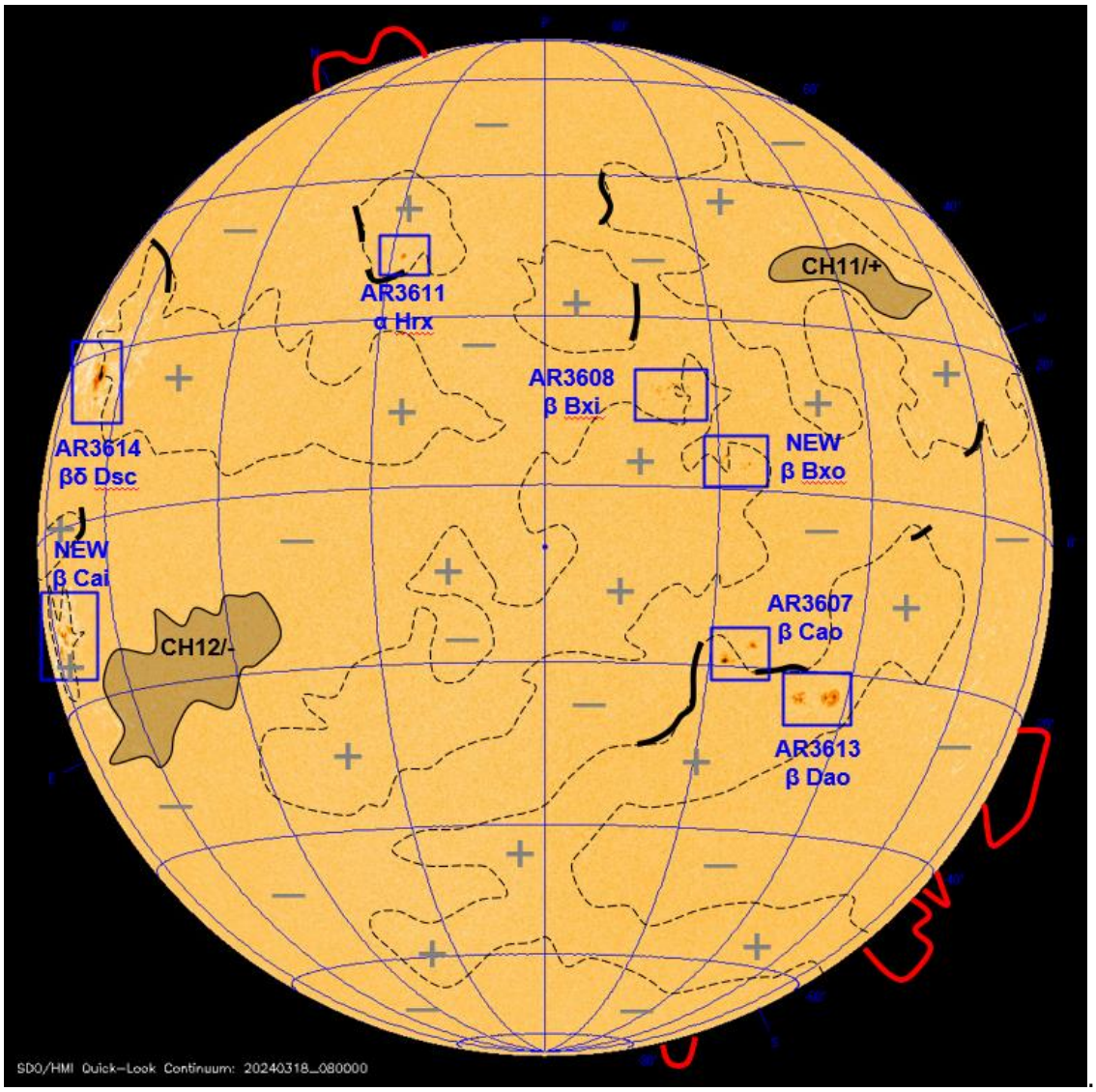
but perhaps also a glancing impact from the slightly fast and further south CME earlier in the day. No other notable enhancements are forecast. Geomagnetic activity is forecast to be mainly Quiet, but increasing to give periods of Unsettled to Active with any CME glance that occurs, most likely with on day 3 (20 Mar), with a slight chance of G1 Minor Storms.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) Proton flux at GOES18 is expected to continuing gradually easing to background levels, with only a slight chance of any further enhancements. High energy electron flux (greater than 2MeV) is expected to persist at mainly background with the associated 24 hour fluence remaining below the Active level.

Figure 1. Solar Analysis Valid 18/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Glancing CME effects are possible day 1 and 2 (17-18 Mar) as CMEs pass south and north of Earth, as well as to the east, ahead of Earth. Any influence is expected to be minimal, but may bring brief periods of Unsettled, perhaps briefly Active geomagnetic activity (Kp 3-4).

A more notable CME was observed from the filament eruption from the southeast disc, occurring near AR3613 at around 17/0230 UTC. This is a complex eruption, resulting into two separate CMEs. The first one is to the southeast, and is faster, narrower but brighter on imagery but likely giving a glancing impact at most earlier on day 3 (20 Mar). The second the southwest is fainter, slower and wider, and consequently more likely to be observed arriving at Earth. This is expected during the second half of day 3, with ongoing effects possible on day 4 (21 Mar), before easing. These will bring a chance of Unsettled to Active intervals day 3-4 with a slight chance of G1 Minor Storm intervals.

Aside from the CMEs, no other sources of notable enhancement to solar winds are forecast, with CH11/+ too far north and unlikely to bring any notable influence. This will result in background wind speeds largely persisting, along with largely Quiet geomagnetic activity.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	40	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/0230	Partial	Filament Eruption	SW	450	20/2000	Limited shock expected. Moderate confidence. Perhaps preceded by glancing blow

Figure 2: ENLIL and Ensemble, which shows potential glancing blows and the CME arriving on the 20th March.

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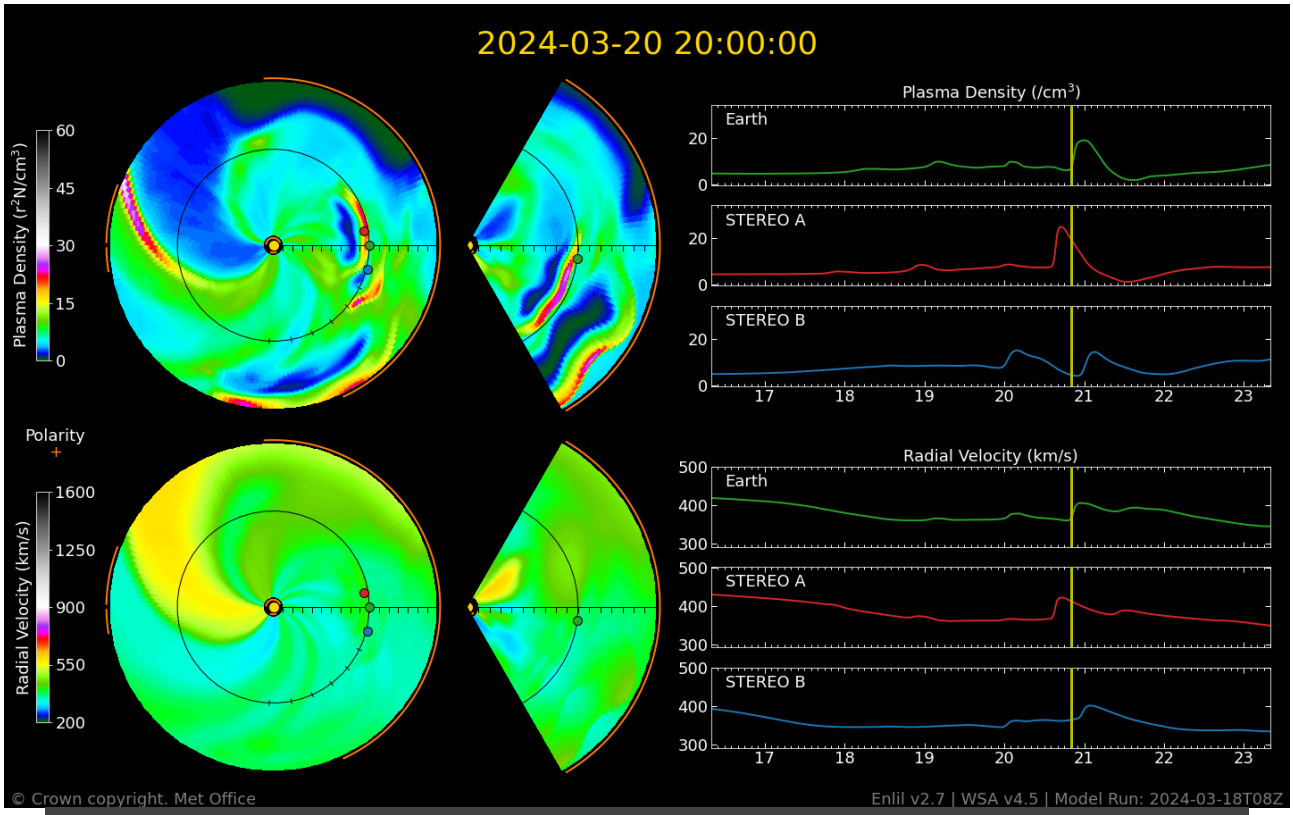

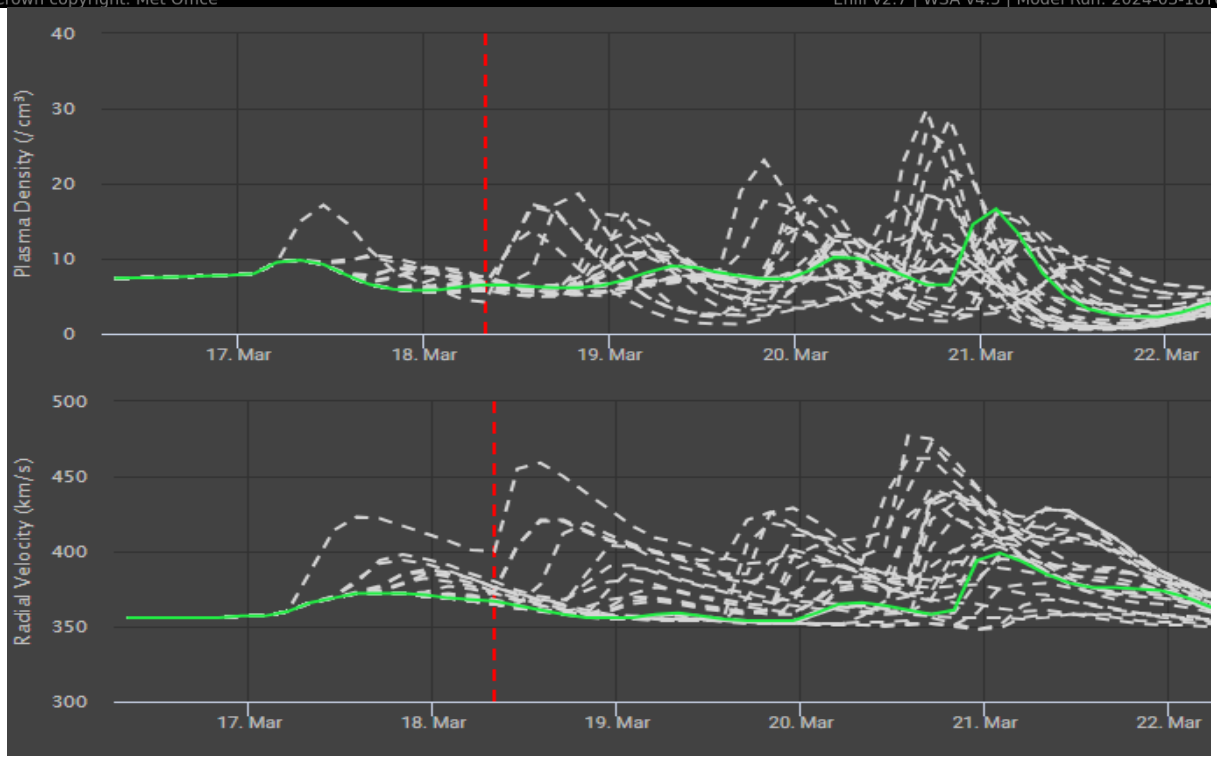

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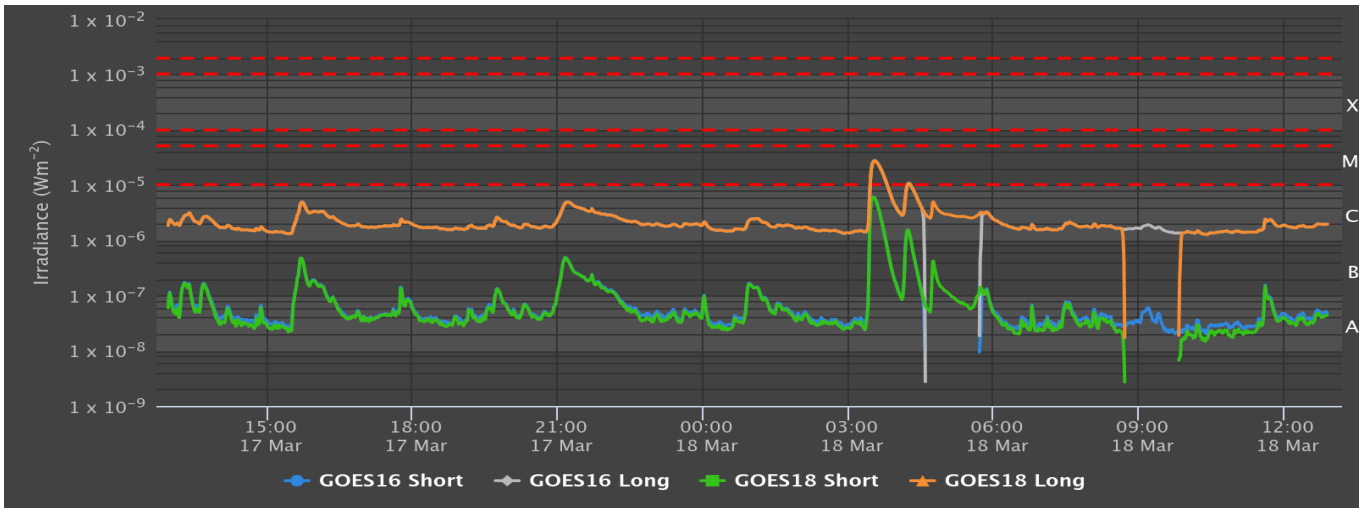
Radio Blackouts - X-Ray Flares:
Low to Moderate activity is forecast with an ongoing chance of Isolated M-flares. Activity is currently on an upward trend, with a couple of new regions rotating onto the disc, and growth evident in a couple of further regions.

Of the seven regions currently on the disc (five numbered), AR3614 is perhaps the most notable, as returning region ex-AR3590 which gave an X6.3 on the previous rotation. This has survived its transit across the far-side, but is now a smaller, albeit still rather complex region. There remains a clear delta configuration, although given the region was decreasing in activity as it rotated off the disc, with a similar delta visible, confidence remains low for any further significant activity. Further details may yet emerge as it moves into a less oblique viewing position.

Also of note, is the new region in the southeast, currently unnumbered. This consists of a number of smaller spots set within plage, and was the source of a number of C-flares and the most recent M-flare on 16 Mar. Further such flares remain possible. AR3613 and AR3619 in the southwest have both also seen some growth in the last 24 hours. These also bring an increased flare risk, especially if any further development occurs.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES18 X-Ray Flux trace.



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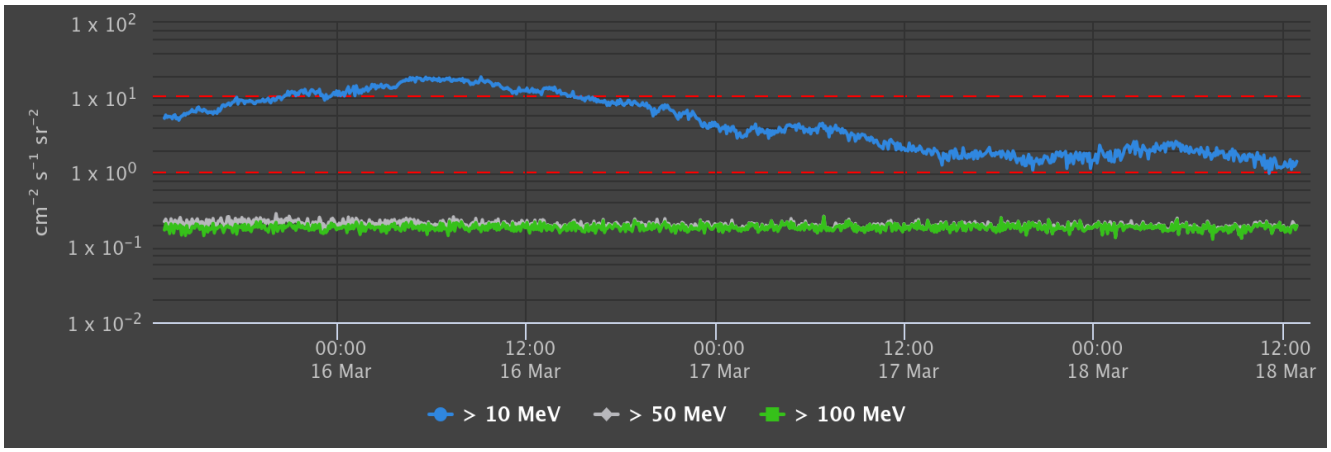
Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18, is currently slightly above background but well below the S1 Minor Radiation Storm level and easing after the recent enhancement on 15-16 Mar. Flux is expected to continue easing to background with only a very slight chance of further enhancements from the sunspots currently on the disc or just over the western limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES16 Proton Flux for the last 3-days – slightly elevated, gradually declining to background levels.



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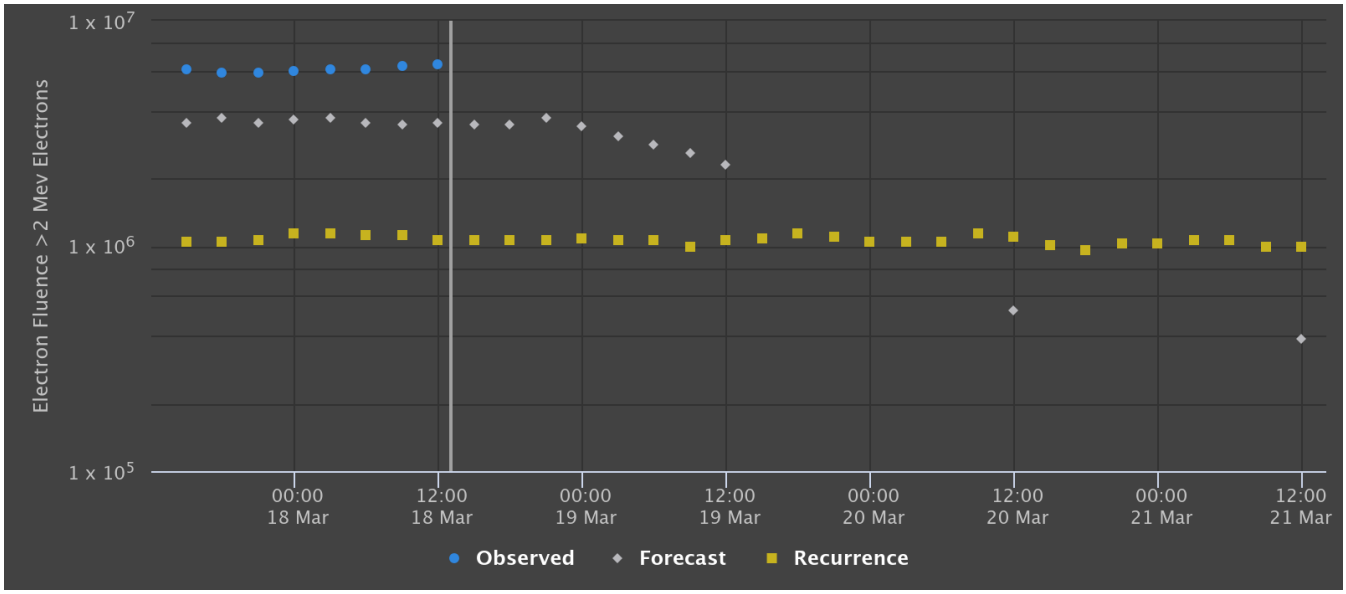
High Energy Electrons Event (≥ 2MeV):
GOES-16 electron flux is expected to remain at mostly background, with no significant sources of enhancement expected, such as the onset of fast wind. Glancing CME impacts may lead to brief Moderate flux, however these are very low confidence. A more likely CME arrival is expected on day 3 (20 Mar) and into day 4 (21 Mar), however this is also likely to only have a minimal impact on the observed electron flux,

The associated 24 fluence is expected to remain below the Active threshold, with MOSWOC REFM in agreement and providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM electron fluence, observations and recurrence.



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